Solutions Network Formulation Report

Improving an Atlantic Fisheries DSS using Sea Surface Salinity Data from NASA's Aquarius Mission

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1. Candidate Solution Constituents

a. Title: Improving Atlantic Fisheries DSS using Sea Surface Salinity Data from NASA's Aquarius Mission

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c. Identified Partners: The University of Massachusetts and Massachusetts School of Marine Science and Technology

d. Specific DST/DSS: SMAST Decision Support System for Fisheries Science

e. Alignment with National Application: Coastal Management

f. NASA Research Results – Table 1:

Mission	Sensors/Models	Data Product
Aquarius Mission	Passive Salinity Sensor L-Band Radiometer operating at 1.4 GHz	Measurements of soil moisture and ocean salinity and of sea ice density and thickness
	Microwave Radiometer	Measurements of surface wind, rain, cloud liquid water, and water vapor and sea ice over the ocean, and possibly snow cover parameters on land
	Infra-red Camera (NIRST)	Measurements of high-temperature thermal events (biomass fires, volcanic events, etc.) and their thermal energy release, as well as limited sea surface temperature data
	FVCOM (Finite Volume Coastal Ocean Model Images)	Measurements of Surface residual circulation, tidal forcing, surface temperature, and surface salinity

g. Benefit to Society: Improved conservation of habitat and ecosystem management and improved fishery management.

2. Abstract

This report assesses the capacity of incorporating NASA's Aquarius SSS (sea surface salinity) data into the SMAST (School of Marine Science and Technology) DSS for Fisheries Science. This data will enhance the SMAST DSS by providing SSS over a large area. Aquarius is a focused satellite mission designed to measure global SSS. SSS mapping is limited because conventional in situ SSS sampling is too sparse to give a large-scale view of the salinity variability. Aquarius will resolve missing physical processes that link the water cycle, the climate, and the ocean. The SMAST Fisheries program provides a DSS for fisheries science. It collects fisheries and environmental data, integrates them into a suite of data assimilation ocean models, and provides hindcasts, nowcasts, and forecasts for fisheries research, fisheries management, and the fishery industry. Currently, SMAST is using SSS data from the National

Oceanic and Atmospheric Administration's National Data Buoy Center. The SMAST DSS would be enhanced with SSS data from the Aquarius mission.

3. Detailed Description of Candidate Solution

a. Purpose/Scope

This report examines the use of NASA satellite SSS data to enhance the SMAST DSS. The fishing industry is the commercial activity of fishing and of producing fish and other seafood products for human consumption or as input factors in other industrial processes. Total fish production in the world in 2001 was 130 million tons (FAO, 2004). Global production from capture fisheries and from aquaculture supplied about 101 million tons of food fish in 2002. Overall, fish provided more than 2.6 billion people with at least 20 percent of their average per capita animal protein intake (FAO, 2004).

In the 1990s and 2000s, it has become increasingly evident that industrial fishing has severely depleted stocks of certain types of ocean fish. A necessary component of moving forward in fishery management is the development of sets of calibrated and scale-matched measurements of fish stocks and the ocean environment. This data can be used to improve the assessment of fish abundance and to develop a suite of ocean observations that are relevant to adult fish distribution (SMAST, 2007a; HotSpots, n.d.).

SSS is becoming an important parameter in locating fish (Castillo et al., 1996; Morita et.al., 2001). Salinity is a measure of dissolved salts in sea water and is calculated as the amount of salt (in grams) dissolved in 1,000 grams (1 kilogram) of seawater. Salinity affects seawater density and thus influences ocean water layering. Higher salinity seawater generally sinks below lower salinity water, leading to stratification by salinity (Bigelow, n.d.). SSS measurements have many societal benefits by providing data that fishermen, scientists, and coastal managers need to develop scientifically based management approaches to protect fish resources (SMAST, 2005).

Oceanic fronts are boundaries between water masses of different density. Density is a function of temperature and salinity; therefore, both thermal (temperature) fronts and haline (salinity) fronts exist in the ocean. A thermal front is a zone with a pronounced horizontal temperature gradient, while a haline front exhibits a horizontal salinity gradient. Ocean fronts can extend from the surface to the very deep layers of the ocean, often separating very large volumes of ocean water (MCGC, 1997). Each species of offshore game fish has a water temperature and SSS range it prefers and a wider range outside of which it will seldom be found. By adding satellite SSS data to the SMAST DSS, users can better predict where to find fish.

b. Identified Partner(s)

The School for Marine Science and Technology is the marine campus of the University of Massachusetts Dartmouth. SMAST is located in the fishing port of New Bedford. Scientists at SMAST have expertise in ocean modeling and monitoring, fisheries science and management, coastal systems science, ocean acoustics, biogeochemistry, remote sensing, and ocean engineering (SMAST, 2004).

The SMAST Fisheries program provides a DSS for fisheries science. It collects fisheries and environmental data, integrates them into a suite of data assimilation ocean models, and provides hindcasts, nowcasts, and forecasts for fisheries research, fisheries management, and the fishery industry (SMAST, 2004). The framework for the fisheries management DSS consists of four programs: Fisheries Observation; Ocean Observation and Dynamics; Ecosystem Modeling and Data Assimilation; and Fish Population Dynamics, Statistical Analysis, and Optimization (SMAST, 2007a).

c. NASA Earth-science Research Results

The Aquarius mission is one of three NASA Earth System Science Pathfinder missions and is designed to provide the first global observations of SSS. The expected launch for Aquarius is 2009 with a life expectancy of at least 3 years, repeating its global pattern every 8 days (NASA, 2007a). Data from the Aquarius mission will deliver monthly 150-km resolution SSS maps with an accuracy of 0.2 *(psu)* (NASA, 2007b). Aquarius will resolve missing physical processes that link the water cycle, the climate, and the ocean (NASA, n.d.).

The payload aboard the Aquarius consists of a passive salinity sensor L-band radiometer (RadSTAR) operating at 1.4 GHz; an active surface roughness sensor L-band scatterometer operating at 1.2 GHz; a microwave radiometer to provide measurements of surface wind, rain, cloud liquid water and water vapor and sea ice over the ocean; and a New IR Scanner Technology (NIRST) for supplementary sea surface temperature (NASA, 2006).

d. NASA Earth-science Models

FVCOM is an unstructured grid, finite-volume, 3D primitive equation turbulent closure coastal ocean model. FVCOM is well suited for simulating the circulation and ecosystem dynamics from global to estuarine scales, particularly for the region characterized with irregular complex coastlines, islands, inlets, creeks, and inter-tidal zones. This model was developed by support from NASA through the SMAST Fisheries Project and the Arctic Region Supercomputing Center (Cowles et al., 2003). SMAST, in collaboration with Woods Hole Oceanographic Institution, is building an integrated high-resolution model system that is capable of hindcast, nowcast, and forecast of the circulation and key ecosystem processes in coastal oceans and estuaries (MEDM, 2006). In addition, the model's flux calculation method with an integral form of equations provides a better representation of momentum, mass, salt, and heat conservation (SMAST, 2007b).

e. Proposed Configuration's Measurements and Models

NASA's SSS data combined with the FVCOM model can produce SSS information that will augment the SMAST fisheries DSS. This data can be used to improve hindcasts, nowcasts, and forecasts for fisheries research, fisheries management, and the fishery industry (SMAST, 2004). SMAST currently receives SSS data from in situ measurements. This information is limited to the number and location of the data retrieval sites. NASA's Aquarius mission will provide SSS on a global scale, which will increase the amount of SSS data for the SMAST Fisheries DSS. There are no anticipated issues associated with the mission start or lifetime.

4. Programmatic and Societal Benefits

Solutions Network products that clearly establish the use of NASA SSS data for fisheries management strongly support NASA's Coastal Management National Application. The addition of NASA SSS data can result in improved accuracy in sea-salinity mapping. This information can aid coastal management by providing data that can be used for fisheries management. Aquarius will resolve missing physical processes that link the water cycle, the climate, and the ocean (NASA, n.d.. SSS data has many other societal benefits, including understanding the water cycle and ocean circulation as well as climatic effects, such as El Niño and La Niña.

SMAST Fisheries has a history of collaboration with NASA and of using NASA satellite data products (SMAST, 2007a). The goal of SMAST Fisheries is to improve the assessment of fish abundance, to develop a suite of ocean observations that are relevant to adult fish distribution, and to develop a means to inter-calibrate the abundance of fish with the ocean environment.

5. References

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